100% Chemical Free[*]

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Non Fiction

"How to create a safe and chemical-free home" advises the Queenstown Lakes district council.[1] Natural Pools NZ, in turn, offers "chemical-free swimming",[2] and a "chemical-free cosmetic" is touted on our evening news.[3] These are some of the many examples of what Chemical and Engineering News has dubbed as the age of "chemophobia",[4] or the irrational and unsubstantiated fear of chemistry and chemicals.

Chemistry is "*concerned with the substances of which matter is composed, the investigation of their properties and reactions, and the use of such reactions to form new substances*",[5] while a chemical is "*a distinct substance or compound,*"[6] and so by its very definition encompasses everything in the world, including ourselves. The phrase chemical-free is therefore not just misleading, but simply ridiculous, yet many people, who now equate chemical with toxic, actively seek out chemical-free products.[7] This leads to a proliferation of goods that proudly advertise being chemical-free, from the chemical-free Miracle Gro fertilizer (never mind that it contains phosphorus pentoxide and potassium oxide among other ingredients),[8,9] through the chemical-free (but mineral!) powder make-up,[10] even including – incredibly – a chemical-free chemistry set![4] While these examples may be excused as pandering to the public at large who misunderstand the words chemistry and chemical, a more recent example is more worrisome still. The prestigious journal Science, presumably aimed at educated scientists, describes a fully "chemical-free" process in their short News

[*] No chemicals were used in the writing of this article. Well, other than the cellulose polysaccharide polymer of the paper, and various dyes and pigments of the ink. And the water, tannins, sucrose and casein protein of the cups of tea drunk during writing.

section, as relating to the production of fibres from milk proteins. The same article that mentions casein biopolymers, also states: "*the entire production process uses no chemicals or pesticides*."[11]

When exactly did chemistry become synonymous with poison, and chemical with toxic?

Historically, the word chemistry derives from the medieval Latin *alchimia*, which is derived from the Arabic *al-kimiya*, which in turn comes from the Greek word *khymeia*. This is most likely related to the Greek words *khymatos* (that which is poured out), *khein* (to pour) and *khymos* (juice, sap), as the first use of *khymeia* was applied to pharmaceutical chemistry which was mainly concerned with juices or plant infusions.[12] The art of *khymeia*, and with it, the word, was passed on from the Greeks to the Arabs. Through them it made its way into Europe by way of Spain, where, now known as alchemy, it was applied to very specific attempts to transmute base metals into gold.[13] Throughout the middle ages, alchemy was often conflated with various spiritual, mystical, mythological and even religious concepts. Not until the 17th Century was the study of matter and its reactions approached in a scientific fashion. The Irish-born Robert Boyle, considered a founder of modern chemistry, was one of the pioneers of the modern experimental method. He laid the foundation for the science of what we now call chemistry, and began its separation from the superstitious and mystic alchemy.[14]

The next few centuries brought staggering advancements in the understanding and application of the field of chemistry, bringing us polymers and plastics, pharmaceuticals and anaesthetics, pigments and dyes, solar cells and silicon microchips. Chemistry is pervasive and everywhere. Everything we eat, everything we are, everything we use is chemistry. It is

present even in such things as your morning muffin, which is leavened by the decomposition of sodium bicarbonate to give bubbles of carbon dioxide, browned by the Maillard reaction of amino acids and reducing sugars, and pops out of the muffin pan because of the serendipitous discovery of the non-stick, fluorinated polymer named teflon. For anyone that still thinks they have something totally "chemical-free": the UK Royal Society of Chemistry has a £1 million prize for any such product.[7,9] Funnily enough, there have been no takers yet.

Yet even as chemistry and chemicals pervade our lives, the words themselves seem to be changing in meaning. Many people now consider the word chemical to mean something made artificially by humans, as opposed to mother-nature made. This "colloquial understanding" of the word is the reason the UK's Advertising Standards Authority did not take action against the Miracle Gro advert, despite complaints by members of the public. The ASA stated that they believed that most viewers would understand the advert to mean that no man-made chemicals are present in this product, and therefore are unlikely to be misled by the claim.[8]

The gradual change in word meaning is a part of any living language, but as Andrew Maynard, Director of the Risk Science Centre at the University of Michigan School of Public Health says: "*from the science community's side, we need to look beyond getting irritated by a misuse of what we consider our language, and both be big enough to realize we don't own the language, and more importantly deep enough to look beyond the words to the meaning/concerns that are behind them*."[15]

The real problem is that a dichotomy has developed where natural is healthy and good, while anything manufactured is toxic and bad. Marketing companies pick up on this fear, and

introduce terms like chemical-free into their product description. Labelling things as chemical-free "*as though that's not only possible, but actually desirable*"[7] only serves to further drive the vicious circle of chemophobia. Recently, the Daily Telegraph ran an article on the use of ozone in food preservation, allowing "*the preservation of food without the use of chemicals*." By that standard, chemicals that are harmful are "chemicals", and chemicals that are beneficial are termed something else.[16] The word chemical seems to evokes images of toxic waste dumps, poisonous food additives, and cancer-causing fumes. According to a recent survey performed by the European Commission, most respondents saw chemicals as harmful, dangerous to the environment and unhealthy, as opposed to beneficial or useful.[17]

The issue here goes far beyond the irksome technicality that nothing can be "chemical-free". It is that the general public, while blaming "those nasty chemicals" for smog, pollution, autism and cancer, is unable to recognize ordinary household chemical-based items (e.g. detergents or paint) as being chemical products.[17]

Chemicals are neither good nor bad. They just are. Whether they come from a natural source, or are made in the factory or lab, if they have the same structure they will possess the same properties. Properties that may be of great benefit to us, but may also be harmful if used inappropriately, either through greed or ignorance. What is needed is education, to give people an understanding of the reactions and processes that improve their everyday life, and the knowledge to make the right purchasing choices and voting decisions. And to give them an appreciation of the awe inspiring complexity and the beautiful simplicity of the science that is chemistry.

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